STUDIES OF THE TERRESTRIAL ENVIRONMENT IN THE VICINITY OF THE E. B. EDDY FOREST PRODUCTS PAPER MILL IN ESPANOLA

1976-1983

A. Spires
J. J. Negusanti

Technical Support Section
Ontario Ministry of the Environment
Northeastern Region

NER-AQTM-02-89

TABLE OF CONTENTS

NO ISBN?
Internal
document
only

STUDIES OF THE TERRESTRIAL ENVIRONMENT IN THE VICINITY OF THE E. B. EDDY FOREST PRODUCTS PAPER MILL IN ESPANOLA, ONTARIO

I SUMMARY

In 1976, the Ontario Ministry of the Environment initiated a program to evaluate the terrestrial effects of the E. B. Eddy Forest Products Kraft Mill in Espanola. Vegetation and soil samples were collected in the vicinity of the mill during the summers of 1976, 1979, and 1983. These samples were analyzed for calcium, chloride, sodium and sulphur. Foliar concentration of sodium and sulphur were significantly correlated with distance from the mills main stack in 1976 but not in 1983. Foliar content of calcium, and chloride could not be significantly correlated with proximity to the mill. Soil levels of all elements tested could not be related to distance from the mill. Concentrations of sodium, chloride and sulphur in foliage samples collected in 1983 were considerably lower at all sites in comparison to the 1976 and 1977 collections. Injury was noted on vegetation growing adjacent to the paper mill between 1976 and 1978. The cause of this injury was unknown. No injury was noted in 1983. The reductions in the foliar concentrations of sodium, chloride and sulphur are believed to be a direct result of the reduction in emission levels due to abatement measures implemented since 1978. The Ministry will continue to monitor the terrestrial effects in the vicinity of the E. B. Eddy Mill.

II HISTORICAL BACKGROUND

In 1899, the Spanish River Pulp Company purchased the property along the Spanish River where the town of Espanola is presently located. In 1904, the townsite was laid out, and groundwood pulp and newsprint production began in 1905.

In 1927, the facilities were purchased by the Abitibi Power and Paper Company, and the production of groundwood pulp and newsprint continued until the mill shut down in 1932. The mill site was used as a prisoner of war camp until sometime in 1943, at which time it was purchased by the Kalamazoo Vegetable Parchment Company (KVP). In 1946, the KVP renovated the old facilities and constructed the existing Kraft mill. At that time, the mill was capable of producing 226 metric tons per day of pulp. Production was increased to 317 metric tons per day by 1955. The producton of newsprint and ground wood was phased out, and the mill began to produce paper and parchment.

In 1966, KVP was bought out by the Brown Corporation of New York, and the plant was expanded to 589 metric tons per day by 1967.

In 1969, the Espanola Mill was purchased by E. B. Eddy Company, Limited, and internal changes were made in the mill to increase the production to 634 metric tons per day of pulp, 90 metric tons per day of paper and 9 metric tons per day of parchment. The parchment plant at Espanola is the only one in Canada and one of the only three in North America.

III ABATEMENT PROGRAM

Around 1970, the cell room, which produced caustic and chlorine from sodium chloride in non-mercury diaphragm cells, was phased out. A Minister's Order was placed on Eddy Forest Products in 1970 to reduce the suspended solids.

In 1977, the first line in the mill was converted to an oxygen bleaching system, which was the first such system in Canada.

In 1978, a Ministry of the Environment Control Order was issued to the Company which dealt with air emissions as well as with the wastewater effluent abatement program.

In 1980, a second oxygen system was installed on the hardwood line to reduce BOD and colour of the effluent discharged to the Spanish River.

In 1981, the old 1945 bleach plant was shut down. The 1965 6-stage bleach plant was split into two bleach plants and combined with the new oxygen and chlorination stages installed in 1977 and 1980. This resulted in two short sequence bleach plants using the bleaching sequence OC_DEHD.

In 1981, the mill embarked on a $215 million modernization expansion program in order to maintain the competitive position in the industry. The main objectives of this program were:

a) To replace all of the old equipment installed prior to the 1960's with the state-of-the-art equipment;

b) To assure environmental compliance as specified in the Ministry of the Environment Control Order issued in 1981; and

c) To increase pulp production by 200 tons per day.

An abbreviated table of measures taken to reduce environmental pollution up to 1984 at the E. B. Eddy mill is shown in Table 1.

This report summarizes results obtained in the Ministry of the Environment's terrestrial surveillance program in the vicinity of the E. B. Eddy paper mill at Espanola between 1976 and 1983.

IV VEGETATION AND SOIL SAMPLING PROGRAM

a) Sampling Procedure

The kraft pulping process generally results in the formation of malodorous sulphur compounds such as methyl mercaptan (CH_3SH), dimethyl sulphide ($(CH_3)_2 S$), dimethyl disulphide ($(CH_3)_2 S_2$), and hydrogen sulphide (H_2S), collectively known as total reduced sulphur (1). Sulphur dioxide (SO_2) may also be released. Certain sections of the kraft mill can emit quantities of particulate matter to the atmosphere, including sodium sulphate (Na_2SO_4), sodium carbonate ($NaCO_3$) and calcium carbonate ($CaCO_3$).

In an effort to determine the terrestrial effects of emissions from E. B. Eddy's Espanola Mill, a program to sample vegetation and soil in the vicinity of the paper mill was initiated in 1976 (2). Eight sampling stations were established at different distances and directions from the mill. The number of sample sites was increased to 13 in 1977 (Figure 1). The sample sites were located in relation to the main stack (powerhouse) as follows:

Site	Distance	Direction
1	230 m	WSW
2	510 m	WSW
3	825 m	W
4	110 m	SW
5	560 m	S
6	1070 m	S
7	470 m	N
8	810 m	N
9	1200 m	N
10	510 m	SE
11	1050 m	SE
12	730 m	SW
13	675 m	NNW

Observations were made on the presence or absence of injury to foliage of vegetation growing near the sampling sites.

Triplicate samples of Manitoba maple (*Acer negundo* L.) foliage and soil (0-10 cm) were collected at each station in 1976, 1977 and 1983.

All samples were returned to the Ministry of the Environment laboratory in Sudbury. Vegetation samples were oven-dried, ground in a Wiley Mill and placed in glass jars. The soil samples were air-dried, ground in a mortar and pestle to pass through a 45 mesh sieve and bottled. The samples were then delivered to the laboratory in Toronto for chemical analysis. The analyses included total sodium, calcium, sulphur and chloride. These elements were selected based on composition of kraft mill emissions and possible fugitive gases resulting from the various processes.

b) Chemical Analysis Results

The Ontario Ministry of the Environment has conducted numerous vegetation and soil sampling programs throughout the Province of Ontario. Based on experience with these programs, as well as on data published in the literature, a set of guidelines has been developed to indicate the concentrations of individual chemical elements which are considered to be above background concentration limits. The values of these guidelines were determined by statistically evaluating data for the Northeastern Region using only samples from uncontaminated sites. The values presented in the table below would only be encountered no more than once in 100 samples on a statistical basis. Values presented do not necessarily mean that there is toxicity involved, but that there is evidence of contamination above average normal levels. The concentration limits of contaminants in vegetation or soil are considered to be tools for use by phytotoxicology investigators in interpreting the results of chemical analyses. Certain limitations exist with these established levels, and investigators must judge their use in supplementing other results and observations from field assessment surveys. Guideline concentrations for those elements pertaining to this report are given in Table 3. The concentrations of the various chemical elements measured in Manitoba maple foliage and soil in the Espanola area are presented in Tables 4 to 9.

i) Sodium:

Sodium concentrations in Manitoba maple foliage and soil are presented in Table 4. Levels in foliage were above the upper limit of normal concentration of 50 ug/g at all sites in both 1976 and 1977, thus indicating the influence of non-natural sources of contamination. In 1983, levels of sodium in foliage were lower such that only eight of the twelve sites sampled exceeded the 50 ug/g level of sodium.

Levels of sodium in Manitoba maple at each location were plotted as a function of distance from the main stack for 1976, 1977 and 1983 (Figures 2 to 4). The equations best describing the data were:

1976:	$Y = 3309 - 3.08\,(X)$	$r = -.86^{**}$
1977:	$Y = 870 - 0.68(X)$	$r = -.67^{*}$
1983:	$Y = 164 - 0.10(X)$	$r = -.42$ ns.

where Y is the concentration of Na in foliage (ug/g)
and X is the distance from the main stack (metres)
** 1% level of significance
* 5% level of significance

Good correlations between sodium concentration and distance were obtained in 1976 (r = -0.86) and 1977 (r = -0.67), with the highest concentrations of sodium in the foliage being measured at those sites nearest to the paper mill. Extrapolation of the equations back to the upper level of normal concentrations (50 ug/g) showed the distance to which sodium levels in foliage were affected by emissions from the stack was approximately

1200 metres. Concentrations in 1977 were considerably lower than in 1976 until, in 1983, the correlation between distance from the stack and foliar sodium concentrations was no longer significant. These reductions are believed to be attributed to pollution abatement measures adopted by E. B. Eddy Forest Products Limited and are outlined in Table 1.

Sodium concentrations in soil were not related to distance from the stack, and sodium would not be expected to accumulate due to its high leachability.

ii) Calcium:

Calcium levels in vegetation and soil are presented in Table 5. Although no significant relationships between foliage concentrations and distance from the stack were observed, the upper level of normal concentration for foliage (3%) was exceeded in 1977 at Sites 1, 3 and 4. Levels in 1983 were considerably lower than in either 1976 or 1977, probably as a result of pollution control measures implemented at the E. B. Eddy mill. Soil calcium levels were variable, and no trends or relationships were observed.

iii) Chloride:

Concentrations of chloride in Manitoba maple foliage were above the upper limit of normal concentration at most sites in 1976 and 1977 and at Sites 4, 8 and 9 in 1983

(Table 6). Chloride levels in foliage showed similar trends to calcium, being higher in 1977 than in 1976 but reduced considerably in 1983. Chloride in soils behaved similarly. No significant correlations between chloride concentration and distance were observed.

iv) Sulphur:

Sulphur contents of Manitoba maple foliage are presented in Table 7. With the exception of Site 1, concentrations of sulphur in the foliage were higher in 1977 than in 1976. Considerable reductions were noted in the 1983 data. Correlations between sulphur concentration and distance were highly significant in 1976 (Figure 5), but were not significant in either 1977 or 1983. The equations of best fit are as follows:

1976:	$Y = 0.59 - 0.0004[X]$	$r = -.84^{**}$
1977:	$Y = 0.55 - 0.0002[X]$	$r = -.50$ ns
1983:	$Y = 0.24 - 0.00004[X]$	$r = -.37$ ns

where Y is the concentration of sulphur in foliage (%)
and X is the distance from the main stack (metres)
** 1% level of significance

The upper limit of concentrations of sulphur in vegetation foliage considered normal is 0.4%. This value was exceeded at three sites in 1976 (Sites 1, 4 and 7) and at six sites in 1977 (Sites 2, 4, 7, 8, 11 and 13). Values were considered normal at all sites in 1983.

Levels of sulphur in soil were above those considered as normal at Site 3 in 1976, Site 2 in 1977 and at Site 11 for each year of monitoring. No trend with soil sulphur content and proximity to the mill was found.

V INJURY TO VEGETATION

In 1976, a white particulate material was visible on the foliage of various plant species in the area southwest of the paper mill (1). This powder was identified as calcium carbonate. Moderate to severe terminal-marginal necrosis of the foliage of Manitoba maple trees growing adjacent to the paper mill (Site 4) was noted.

Observations made in 1977 indicated that injury to several different species of vegetation was present at Sites 1 and 4, and the type and severity of injuries are noted in Table 2. Similar injury in 1978 could be observed in trace amounts throughout the Town of Espanola and to a greater degree of severity at Site 4 and in front of the Espanola Hospital. Causes of these injuries were unknown.

No abnornal injury to vegetation was present in 1983.

CONCLUSIONS

Vegetation and soil sampling survey conducted in the vicinity of E. B. Eddy Forest Products Limited, Espanola, have resulted in the following observations:

1. Sodium concentrations in foliage were significantly correlated with distance from the stack in 1976 and 1977, but not in 1983. They were above levels considered normal at most sites in 1976 and 1977 but have been reduced by pollution abatement measures adopted by the E. B. Eddy company since 1978.

2. Chloride in maple foliage was above the level considered as normal at most sites in 1976 and 1977, and three sites in 1983. The levels in 1983 were reduced compared to the previous years.

3. Concentrations of sulphur in foliage were considered above normal at approximately 50% of the sites sampled in both 1976 and 1977. In 1983, levels of sulphur in vegetation at all sites were considered normal.

4. Calcium levels in vegetation were variable and no trend with proximity to the mill was found.

5. Soil levels of all elements listed could not be related to distance from the main stack.

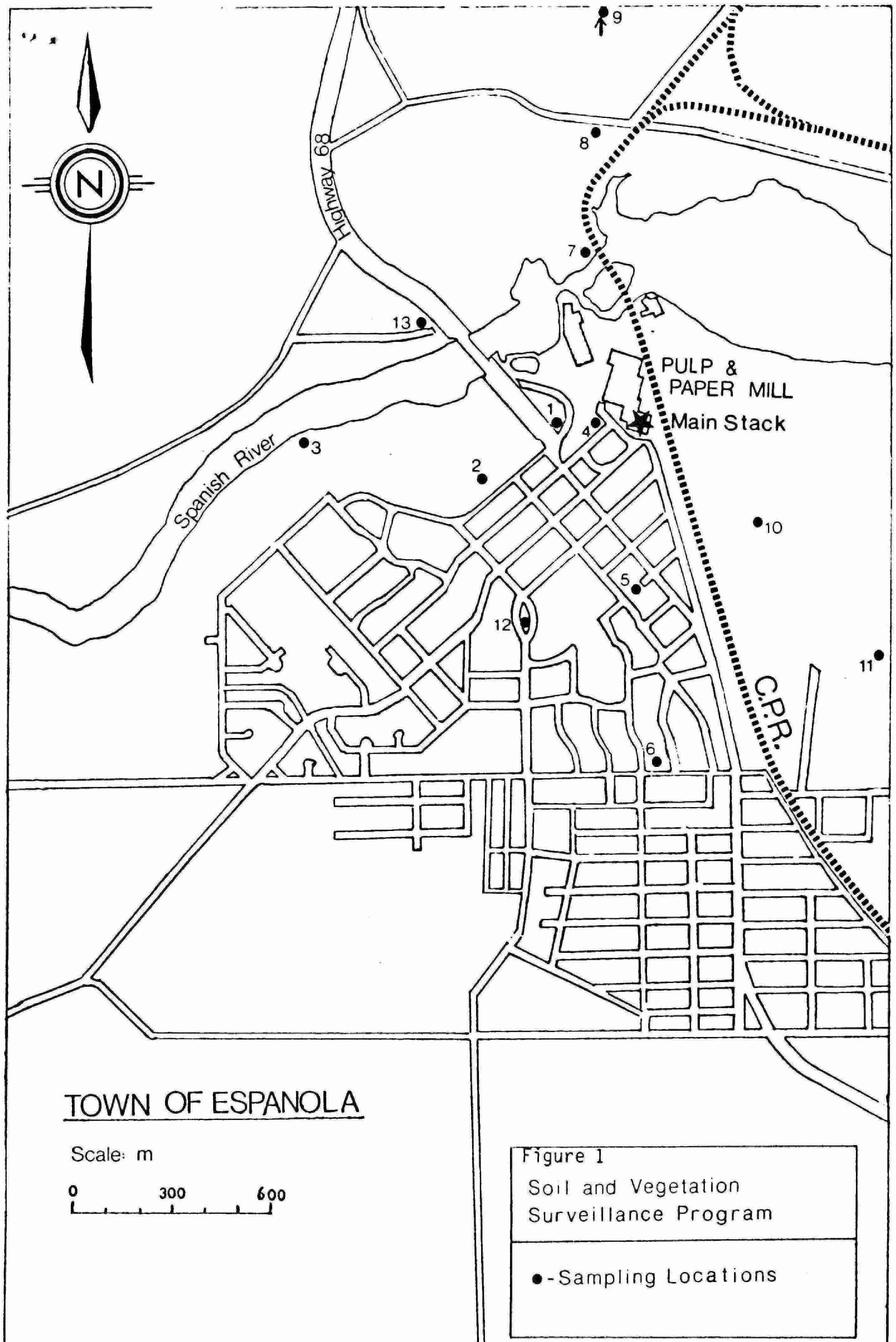
6. Injury was noted on vegetation growing adjacent to the paper mill between 1976 and 1978. The cause of this injury was unknown. Injury was not noted in 1983.

The reductions in the foliar concentrations of sodium, chloride and sulphur are believed to be a direct result of the reduction in emission levels due to abatement measures implemented since 1978. These conclusions are based mainly on the reduced levels observed in 1983 and need to be confirmed by future sampling. The current surveillance program is carried out every five years; thus, the next soil and vegetation sampling program will be undertaken during the summer of 1988.

VII BIBLIOGRAPHY

1. Ontario Ministry of the Environment, 1980. Report on Ambient Air Survey in Espanola. Air Resources Branch, Toronto. ARB-TDA Report No. 11-80, 60 pp.

2. Potvin, R., W. D. McIlveen and P. C. McGovern, 1977. Air Quality Assessment Studies for the Town of Espanola. Ontario Ministry of the Environment, Northeastern Region. 44 pp.



N
Highway 68
Spanish River
PULP & PAPER MILL
Main Stack
C.P.R.
1
2
3
4
5
6
7
8
9
10
11
12
13
TOWN OF ESPANOLA
Scale: m
0
300
600
Figure 1
Soil and Vegetation Surveillance Program
●-Sampling Locations

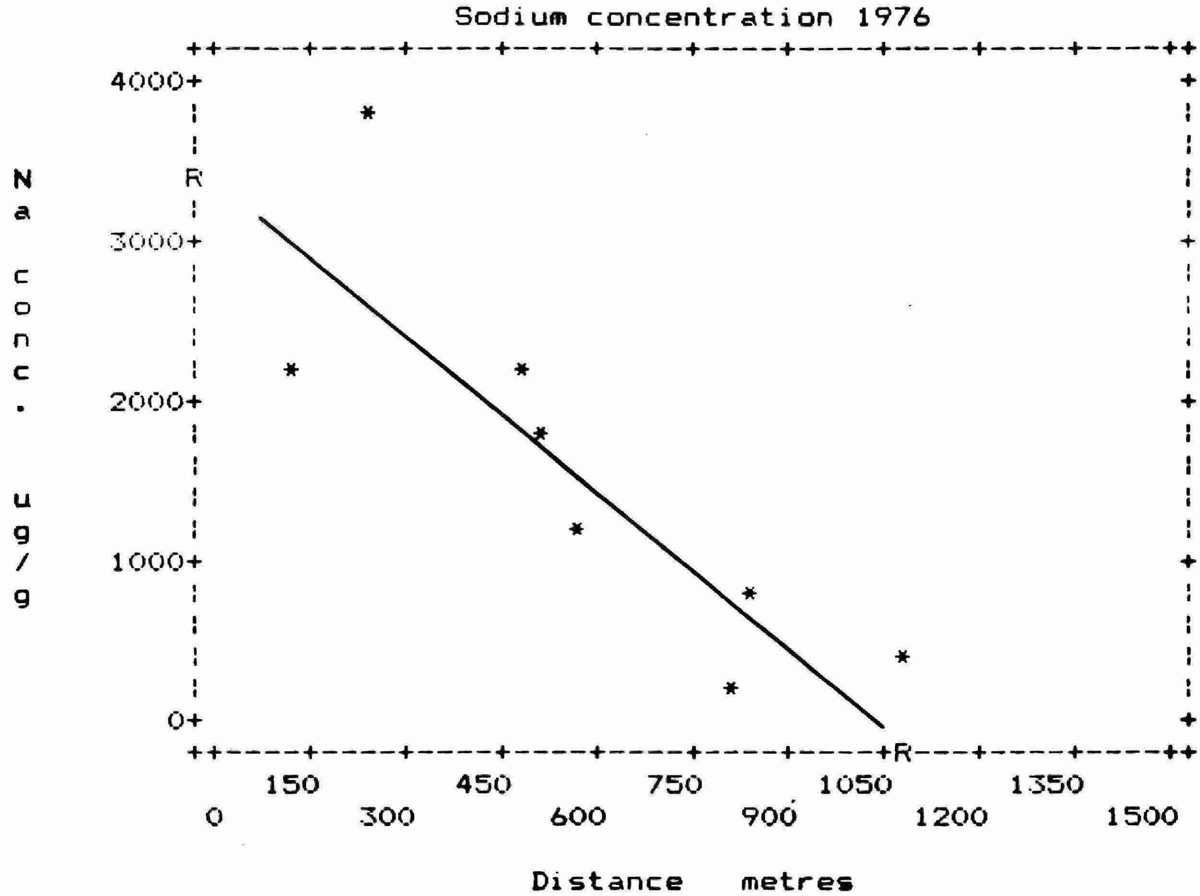


Figure 2 **1976 Sodium Concentrations in Foliage of Manitoba Maple at Various Distances from the Stack at Espanola.**

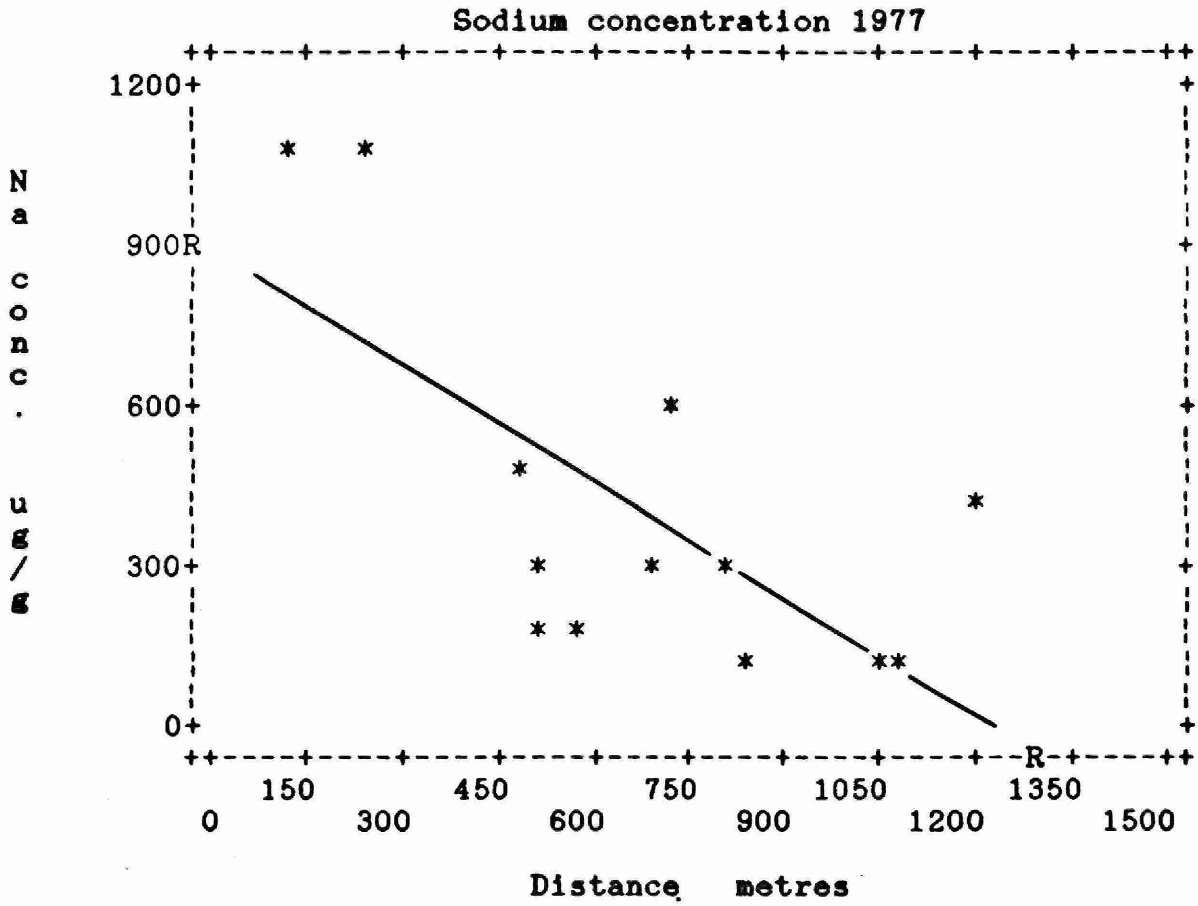


Figure 3 **1977 Sodium Concentrations in Foliage of Manitoba Maple at Various Distances from the Stack at Espanola.**

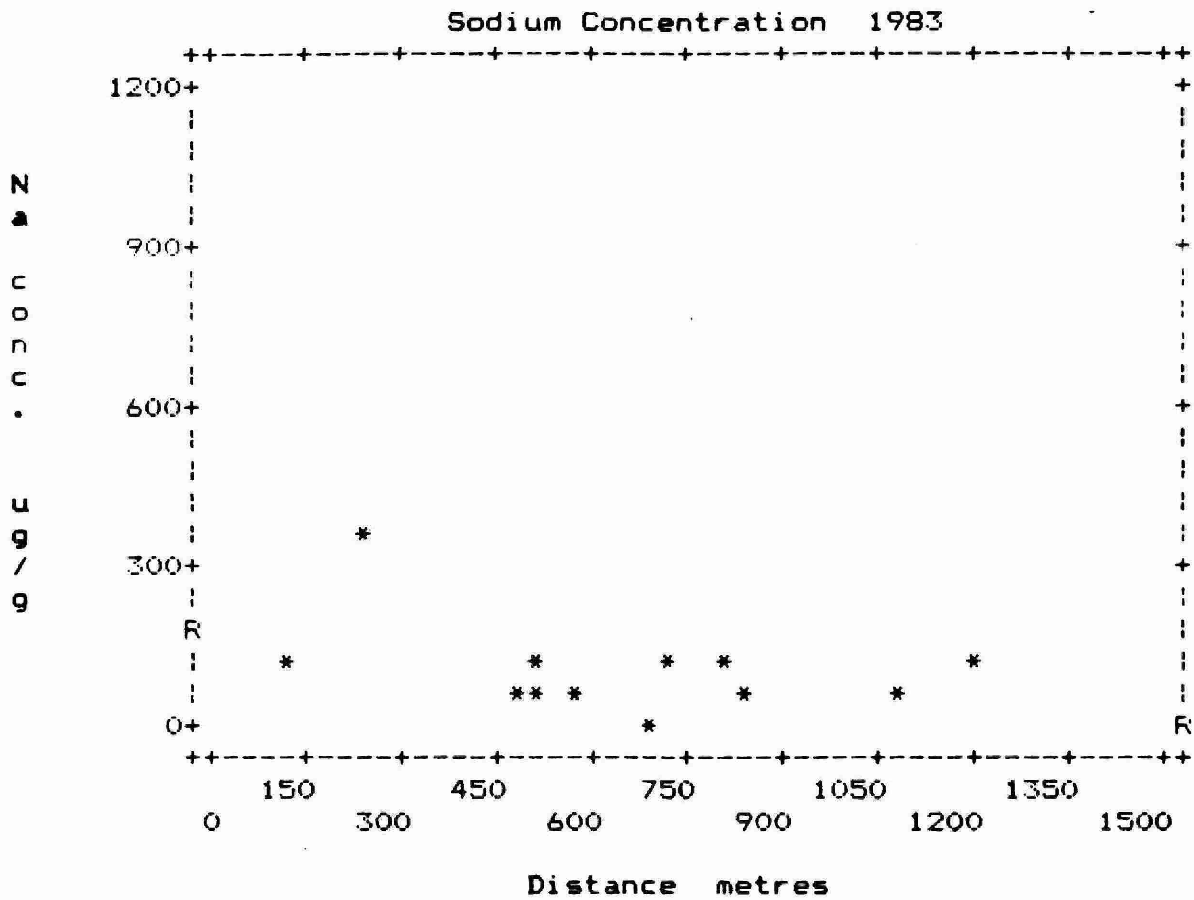


Figure 4 **1983 Sodium Concentrations in Foliage of Manitoba Maple at Various Distances from the Stack at Espanola.**

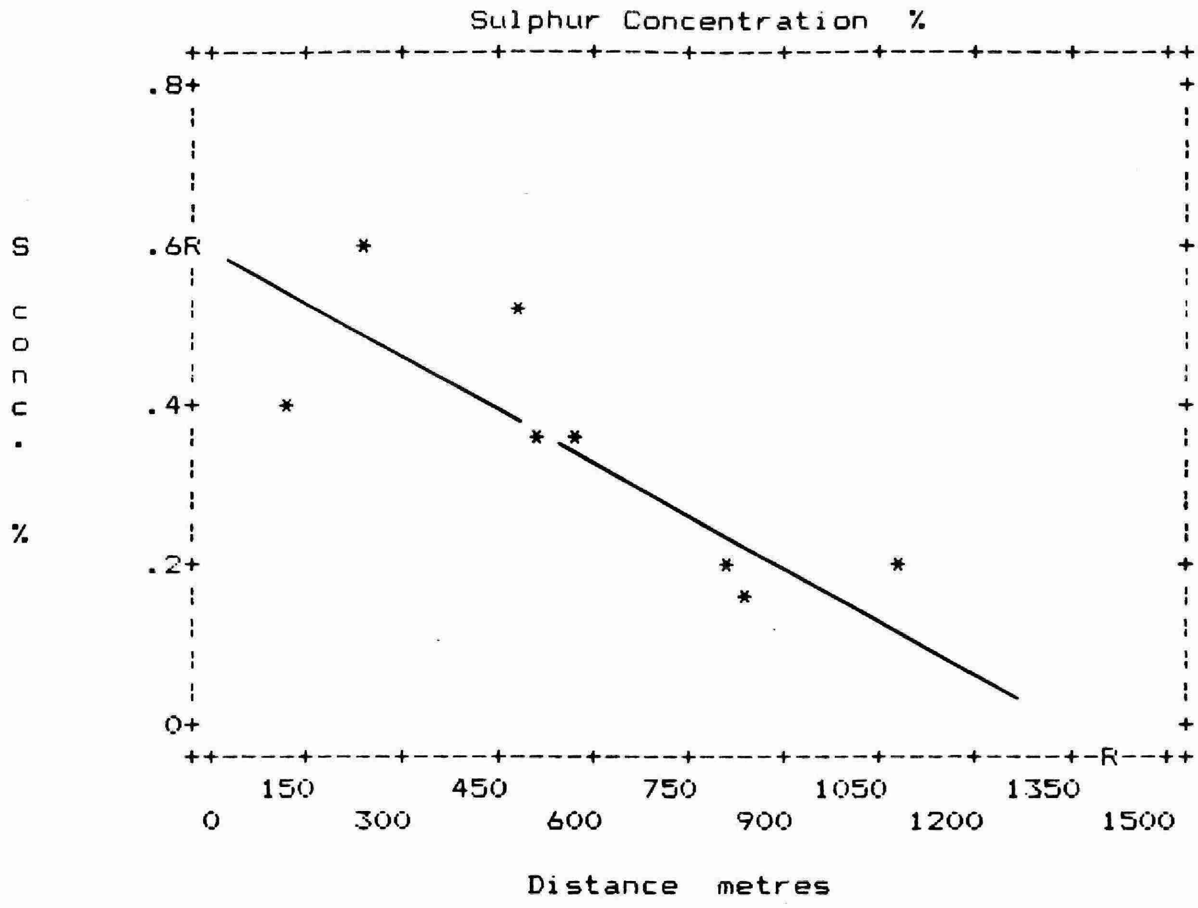


Figure 5 **1976 Sulphur Concentrations in Foliage of Manitoba Maple at Various Distances from the Stack at Espanola.**